Use Case for computing Integrated Kinetic Energy (IKE)

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Summary

Recent research on new measures of intensity compute integrated kinetic energy from the surface wind field. Damage potential ratings are based on a 1-5 scale with 5 being the most severe. A storm surge/waves damage potential metric is based on the sum of KE values of volume elements associated with marine exposure wind analysis grid cells in which the wind speeds are >= 33 m/s. A wind damage potential metric is based on contributions from winds of >= 25 and < 41 m/s, >=41 and < 55 m/s, and >= 55 m/s. IKE values for winds in excess of tropical storm and hurricane force are also computed.

1. Kinetic Energy (KE) Calculation

Input: wind speed at each marine gridded field grid point, size of grid interval or spacing in km

for every cell with a marine exposure wind speed >= 17 m/s

a. WS = SQRT (U^2 + V^2)

b. KE = 0.5 * WS^2 * DG^2 * Z

Where

U = east-west wind component (m/s)

V = North-south wind component (m/s)

WS = Wind Speed in m/s

DG = Grid interval in meters

Z = vertical thickness of grid volume element (use Z = 10 m)

2. IKE_{17} = Sum (all IKE values for winds >= 17 m/s) / 10^12

Note: Dividing by 10^12 results in Terra Joules (TJ)

3. $IKE_{25\text{-}40}$ = Sum (all KE values for winds >= 25 m/s and < 41 m/s) / 10^12

4. IKE_{33} = Sum (all KE values for winds >= 33 m/s) / 10^12

5. $IKE_{41\text{-}54}$ = 6.0 * Sum (all KE values for winds >= 41 m/s and < 55 m/s) / 10^12

6. $IKE_{>55}$ = 30.0 * Sum (all KE values for winds >= 55 m/s) / 10^12

7. $IKE_{25\text{->}55}$ = Sum ($IKE_{25\text{-}40}$ +$IKE_{41\text{-}54}$ + $IKE_{>55}$

8. IKE_{105} = Sum (all KE values for winds >= 54.1 m/s) / 10^12

8. Storm Surge and Wave Damage Rating

Surge/Wave Cat = 1.62331056091026 + 0.00773947037258303 * IKE_{33}
-0.0000074504621266874 * (IKE_{33} - 308.5) ^ 2

9. Wind Damage Rating

Wind Cat 4-5 = 3.313 + 0.665 Log_{10} IKE_{55}

Wind Cat 0-3 = 0.708 + 0.001728 ($IKE_{25\text{->}55}$) - 0.00000052263 ($IKE_{25\text{->}55}$ - 1090.2)^ 2

10. Product Annotations

These five values would be added to the analysis image or annotation surrounding the image

Damage Potential Rating Wind: 3.5 Surge/Waves: 2.1

Integrated Kinetic Energy >TS: 2000 TJ >Hurricane: 500 TJ >105 kts: 60 TJ